Can continuing professional development utilizing a game-centered approach improve the quality of physical education teaching delivered by generalist primary school teachers?

Article

Can continuing professional development utilizing a game-centered approach improve the quality of physical education teaching delivered by generalist primary school teachers?

Andrew Miller

(School of Education) University of Newcastle, Australia

Narelle Eather

(School of Education) University of Newcastle, Australia

Shirley Gray

(Moray House School of Education) University of Edinburgh, United Kingdom

John Sproule

(Moray House School of Education) University of Edinburgh, United Kingdom

Cheryl Williams

(School of Education) University of Newcastle, Australia

Jennifer M Gore

(School of Education) University of Newcastle, Australia

David R Lubans

(School of Education) University of Newcastle, Australia

Conflict of interest:

The authors declare that there is no conflict of interest.

Acknowledgements:

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

The PLUNGE research group acknowledges Dr Wendy Miller for her contribution to all of our lives. RIP Wendy.

Corresponding author:
Andrew Miller**,** School of Education, University of Newcastle, Australia, EN 205, 10 Chittaway Rd, OURIMBAH, NSW, 2258.
Email: Andrew.miller@newcastle.edu.au

Abstract

The primary objective of this study was to evaluate the efficacy of a continuing professional development (CPD) intervention in producing changes in physical education (PE) teaching practice and PE teaching quality by generalist primary school teachers when the CPD addressed the use of a game-centered approach. A cluster-randomized controlled trial was conducted in seven primary schools in the Hunter Region, New South Wales (NSW), Australia. One year six teacher from each school was randomized into the Professional Learning for Understanding Games Education (PLUNGE) intervention (n = 4 teachers) or the 7-week wait-list control (n = 3) condition. The PLUNGE intervention (weeks 1 – 5) used an instructional framework to improve teachers' knowledge, understanding and delivery of a game-centered curriculum, and included an information session and weekly in-class mentoring. The intervention was designed to enhance content and pedagogical knowledge for the provision of pedagogy focused on a broad range of learning outcomes. Teaching quality was assessed at baseline and follow-up (weeks 6 & 7) via observation of two consecutive PE lessons using the Quality Teaching Lesson Observation Scales (NSWDET, 2006). Linear mixed models revealed significant group-by-time intervention effects ($p<0.05$) for the quality of teaching (effect size: $d=1.7$). CPD using an information session and mentoring, and a focus on the development of the quality of teaching using a game-centered pedagogical approach was efficacious in improving the quality of PE teaching among generalist primary school teachers.

Word count: 6777

Keywords:
Teacher effectiveness, Teaching quality, Physical education, CPD, Professional development, Professional learning, Game centered.

Introduction

Continuing professional development (CPD) has been identified as an area of need for generalist primary teachers to improve physical education (PE) outcomes for children (Sloan, 2010; Morgan and Hansen, 2007). Generalist primary teachers have shown to hold only 'moderate' levels of confidence in their PE teaching abilities (Morgan and Bourke, 2008), and combined with a lack of expertise, many describe PE programs as being inadequate for achieving outcomes (Morgan and Hansen, 2008), with the majority identifying the need for more PE professional development (Morgan and Hansen, 2007).

PE outcomes continue to evolve through updated curriculum (ACARA, 2015), and primary school teachers are becoming increasingly accountable for developing their PE programs to target current public health issues (USDHHS, 2012; McKenzie and Lounsbery, 2013). In-class physical activity (PA) levels (Lonsdale et al., 2013) and fundamental movement skill (FMS) development (Lubans et al., 2010) are targeted for promotion in PE due to the declining levels of PA and FMS amongst young people (Hardy, 2010; Hallal et al., 2012). When combined with issues of a crowded curriculum and assessment requirements (APPA, 2014), generalist primary school teachers with low levels of teaching efficacy and a lack of content and pedagogical knowledge in PE (Petrie, 2010; Sinelnikov et al., 2015; Ward, 2013; Dyson, 2014), are unlikely to

develop the confidence or competence to implement quality PE programs. Evidently, generalist primary school teachers are in need of assistance through CPD.

There is a growing body of qualitative evaluation of CPD programs within primary PE (Petrie, 2010; Harris et al., 2010; Coulter and Woods, 2012), and these investigations have generally been undertaken from a theories of change perspective (e.g. how and why a CPD intervention is effective) (Weiss, 1995). Whilst evaluation of this type provides valuable information validating what is considered effective within PE-based CPD, the outcomes reported are typically changes in teacher perceptions rather than observed or measured teaching behaviour and, to date, there is limited evidence linking specific CPD directly to changes in teaching practice (Guskey and Yoon, 2009).

Previous research of the effects of CPD interventions on teaching behavior in primary PE (McKenzie et al., 1998; Sallis et al., 1997; McKenzie et al., 2004; van Beurden et al., 2003) utilized a situated learning perspective (Lave and Wenger, 1991). These studies involved teachers as both learners and teachers (Darling-Hammond and McLaughlin, 1995), incorporated CPD within the school day (Garet et al., 2001), involved experts in the field (Armour and Yelling, 2007), and were integrated into practice (Garet et al., 2001; Armour and Yelling, 2007). These studies display efficacy in producing changes in measured teaching behavior, but it must be noted that the perspective with which PE is viewed, and the outcomes considered important will

determine the notion of what is effective CPD (Armour et al., 2015). The aforementioned investigations valued PE as an avenue for PA related outcomes. As a result, a reduction in managerial time and an increase in fitness and skill drill activities were rated as the valued teaching behaviors. The point here is that framing PE CPD from a public health perspective by solely targeting PA outcomes only serves to narrow the notion of effective CPD.

Whilst these PA related teaching outcomes are important in PE, and the previous CPD interventions displayed efficacy in changing teaching behaviours, PA related outcomes only form part of the espoused outcomes within many curriculum documents. For example, the PE outcomes within the Australian PE curriculum emphasise: i) moving our body, ii) understanding movement, and iii) learning through movement (ACARA, 2015), with students expected to be able to: i) demonstrate fair play and skills to work collaboratively, ii) perform specialised movement skills and sequences and combine movement concepts and strategies to achieve movement outcomes and solve movement challenges. We argue that teaching behaviours focused purely on reduction in managerial time, and an increase in fitness based activities and skill drills are unlikely to achieve broader curriculum outcomes, and what is valued during effective PE CPD should be considered more broadly than has been evident previously.

A game centered approach (GCA) situates learning within game play (Kirk and MacPhail, 2002), asking learners to actively interact with the individual, environmental,

and task constraints placed upon them (Chow et al., 2007). Responding to the constraints within game play requires the learner to process information (perception) and provide movement responses (action), forming a perception-action coupling (Gibson, 1979). This process contextualizes learning of skills within the games they will be played in, with skills learnt more likely to be transferrable to actual game performance situations (Chow and Atencio, 2012).

This approach stems from methods such as Teaching Games for Understanding (Bunker and Thorpe, 1982), Game Sense (den Duyn, 1997) and the Tactical-decision learning model (Gréhaigne et al., 2005). Each of these models, whilst nuanced, is based on the premise that game understanding and decision making is not dependent on the prior development of sport specific movement techniques (Stolz and Pill, 2014). Student understanding emerges 'in and through' learning processes, rather than in a linear manner (Biesta, 2010: 6), and each individual can/may react differently to the learning process, thus this pedagogical approach is said to be non-linear (Atencio et al., 2014).

Use of a GCA has recently displayed a positive effect on a student's ability to play invasion games through improvements in support play and decision making (Miller et al., 2016). Additionally, a GCA has demonstrated a simultaneous effect on in-class PA and FMS development (Miller et al., 2016; Miller et al., 2015), with these effects equivalent to interventions focused solely on PA related teaching behaviors (McKenzie et al., 1998; Sallis et al., 1997; McKenzie et al., 2004; van Beurden et al., 2003).

A GCA has the potential to address multiple curriculum and health promotion goals via a simultaneous focus on: i) socio-cultural aspects through promotion of a mastery climate within dynamic and interactive activities (Meece, 1991; Ames, 1992); ii) physical skill outcomes through promotion of FMS within activities (Lubans et al., 2010); iii) game performance outcomes through development of fundamental game skills (Smith, 2014) and common sports-related tactics (Memmert and Harvey, 2010); and iv) in-class PA recommendations through promotion of high levels of moderate-to-vigorous physical activity within active game play (Lonsdale et al., 2013; Fairclough and Stratton, 2006).

Whilst the results of using a GCA methodology are clearly positive, difficulties arise in the complexity of obtaining multiple outcomes simultaneously. Teaching using a GCA requires content knowledge from multiple knowledge bases (e.g. socio-cultural aspects, motor-skill development, rules, tactics, motivation, the students), and pedagogical knowledge (e.g. organizational strategies, types of activities, feedback techniques), and generalist primary teachers who receive a limited amount of PE specific teacher education training are likely to lack the knowledge required to successfully undertake this method of teaching.

To date, there are few studies investigating the impact of CPD on teaching behavior when the teaching behavior is focused on: i) achieving a range of outcomes that are relevant to the specified curriculum, and ii) achieving public health related

recommendations in PE classes. As research consistently reports that the quality of teaching a student receives is positively related to their academic achievement (Rowe, 2003; Rockoff, 2004; Amosa et al., 2007; Hattie, 2008; Darling-Hammond, 2000) the aim of this study was to evaluate the efficacy of a CPD intervention in producing changes in PE teaching practice and teaching quality when the CPD addressed the use of a GCA.

The Professional Learning for Understanding Games Education (PLUNGE) CPD intervention was based on a transformative model of CPD (Kennedy, 2005), in which the combination of an information session and situated in-class mentoring (Lave and Wenger, 1991) was used to bring about change in teacher practice. An instructional framework was utilized within the intervention to assist in learning about, and delivery of, the game-centered curriculum designed by the research team. This framework served to operationalize researched constructs of teaching associated with high intellectual quality (Newmann, 1991; Newmann et al., 1996), a quality learning environment (Marks et al., 1996), and the promotion of self-determined motivation through personally significant learning (Ryan and Deci, 2000).

PLUNGE was evaluated using a clustered randomized control trial (RCT) with a 7-week wait-list control group (5-week CPD & 2-week follow-up assessment). It was hypothesized that teachers in the intervention group would display the ability to deliver GCA lessons, and compared to those in the control group, would display a higher

quality of teaching as measured by the Quality Teaching Lesson Observation Scales (NSWDET, 2006).

Methods

Study design

The PLUNGE intervention was evaluated using a clustered randomized controlled trial in seven schools. The PLUNGE study conformed to the Consolidated Standards of Reporting Trials guidelines (Moher et al., 2010) and was registered with Australia and New Zealand Clinical Trials registry (ACTRN12613000605796). Ethical approval was obtained from the University of Newcastle ethics committee. Written informed consent was provided by the schools and teachers involved prior to baseline assessment via return of a consent document sent to the school. The study was conducted from September to December, 2013 (7 week intervention followed by a 7 week period for the control group).

Recruitment and participants

Ten primary schools selected randomly from Newcastle Maitland Catholic Diocese Schools, NSW Australia, were invited to participate in the study through an information and consent package (return consent form to indicate school participation). One teacher of a year five or six class (10 – 12 years of age) from each consenting school was

invited to participate in the study. To maintain generalizability of results to the majority of generalist primary school teachers, a teacher was excluded from the study if they: i) held an external sports coaching qualification, or ii) held a tertiary PE teaching qualification.

Randomization and blinding

Schools were stratified into low (<970), medium (>970 and <1000) and high (>1000) socio-economic groups using the Australian Bureau of Statistic's Socio-Economic Indexes for Areas. Schools matched within these strata (minimum two schools per strata) were randomly assigned after baseline assessment to the intervention condition or a usual practice (wait-list control) condition by an independent third party using a coin toss.

Teachers in the control condition schools were asked to teach from the Games and Sports strand of the New South Wales (K-6) Personal Development Health and Physical Education syllabus (Board of Studies New South Wales, 2007) from baseline to follow-up assessment (weeks 6 & 7) to match the syllabus content of the intervention curriculum. The wait-list control group received no information or intervention before attending the follow-up assessments, undertaking the intervention after follow-up assessment.

Professional development intervention

The 5-week PLUNGE intervention focused on improving teachers' understanding and delivery of a game-centered curriculum, and the enhancement of their PE teaching skills. The PLUNGE program was based on the transformative model of CPD (Kennedy, 2005), in which a combination of CPD strategies are used to bring about change in teacher practice. All CPD components were delivered by the first author (AM), who had over a decade of coaching experience across a variety of invasion and net/wall activities, with experience from recreation through elite level and junior through senior cohorts. Further, the first author also had research experience in a GCA, and had instructed the programming and delivery of GCA methods within teacher education programs. The PLUNGE CPD involved two major components:

Teacher information session

This session was based on the training model of professional learning, in which content was delivered to teachers in a passive manner, with controlled, standardized content delivery (Kennedy, 2005). Despite its decontextualized nature, this form of CPD has been acknowledged as an effective method of presenting new information (Hoban, 2002). Content delivered in this one day (6 hour) theory-based session is outlined in Table 1.

Teacher mentoring

Teachers received consultation regarding the presentation of the game-centered curriculum, and in-class scaffolding and feedback regarding curriculum delivery for the first five weeks of the intervention period (Table 1).

Mentoring served to ensure teachers understood the format and purpose of the designed lessons, and for teachers to observe, implement and trouble shoot the theoretical content with a member of the research team within the authentic context of their class. The mentor had greater involvement in the first two lessons, taking the role of the teacher to demonstrate the setup, management and teaching components for two of four activities in the first lesson to provide a model of practice for the classroom teacher. The mentor progressively withdrew instructional assistance of the class from this point (but maintained feedback to the teacher), providing limited feedback to the class in weeks three and four (one of five activities), and only providing instructional/teaching suggestions and feedback to the teacher in the final two lessons. The mentoring model (Kennedy, 2005; Rhodes and Beneicke, 2003) is underpinned by situated learning theory (Lave and Wenger, 1991) and moves to contextualize the theoretical content presented to teachers.

(Table 1 roughly here please)

Curriculum

Lesson content for the 7-week study period (5-week CPD & 2-week follow-up assessment) was designed by the research team. In line with design recommendations for non-linear pedagogy (Tan et al., 2011), the complexity of game-based activities increased progressively across the intervention period to ensure the tactical complexity of activities was not above the ability levels of participants. Initial activities were focused on target activities in pairs, with movement into small and large group invasion game structures throughout the intervention. Table 2 outlines the focus and overviews the content of the designed curriculum.

(Table 2 roughly here please)

Instructional framework to support game-centered pedagogy

To assist the teachers facilitate the game-centered curriculum, an instructional framework was established. This framework was a mixture of classroom management techniques designed to reduce non-outcome related class time and pedagogical techniques and content knowledge for promotion of student learning within game-centered activities. The instructional framework consisted of:

Organize – Arrangement of students into the teams, pairs or groups that were required for the activity. This process remained teacher-centered in order to minimize the time impact on the class, but as teachers gained efficacy in management of the class, this

could be less teacher-centered to serve the same time-saving purpose and include greater amounts of student control over the class environment.

Move – Movement of students to the spaces that they were about to perform the designated activity in. This process was an attempt to improve retention of instructions by reducing time between instruction and activity. The goal was to obtain higher student exposure to activity in which learning could be situated.

Give – Teachers "give" a description of the game process (overall concept with 2-3 key rules) with a simultaneous demonstration by the teacher. The purpose of this process was to give students an oral and visual working model of the activity to be undertaken. The goal was to get the activity moving as quickly as possible, with as many students as possible understanding what they were undertaking. Teachers were asked to keep this phase as short as possible, and not to give specific technique points or strategic information in this phase (unless it was required by a rule of the game).

Try – Students were given the opportunity to experience the activity with minimal rules in place.

Evaluate – Whilst students undertake the activity, the teachers observe and evaluate the activity against four themes:

i) Game – is the activity providing learners with enough opportunity to undertake

the physical and/or game skills required by the activity?

ii) Physical skills – how are learners using their own level of skill within the construct of the activity to solve the physical problem/s presented?

iii) Game skills – how are learners performing tactically within the construct of the activity and the rules given?

iv) Socio-cultural skills – how are learners interacting with each other in line with the class negotiated definition of successful team-work and involvement in class activities?

Stop – Information gathered from the observations of play was then used to pause the class quickly to either:

i. Modify – inclusion of more rules/constraints for the purposes of improving the emphasis on the desired outcomes, provide a smoother running activity, making the activity more equitable for learners, or to present a challenge differently.

ii. Learn – address performance of physical skills, game skills or socio-cultural skills within the activity. When learning was the goal of the stoppage, teachers were asked to provide separate stoppages dedicated to promotion of physical skill and game skill performance at some point during the activity.

This was undertaken via the use of:

- Questioning to establish cognition about an area of the game that could work better, and how to perform the activity more competently for the area of focus (e.g. what is happening in the activity? What can we do to stop that or play more effectively?).

- Recognition of quality performance (and why it was a quality performance) in one of the focus areas within an activity. A recount of what happened within the game is given during this recognition.

iii. Connect – connection of activity or lesson outcomes (skill, tactic or behavior) to previous experiences the student may have had. These experiences may be from within the program (e.g. reference back to tactics that are similar across games used in the intervention), or from outside of the school environment (e.g "who's seen a baseball pitcher throw?" to promote rotation during throwing, "do netball players on the T.V crowd around the ball?" to promote space, "pro athletes go and give support to their team-mate if something goes wrong for them, don't they?" to promote socio-cultural outcomes).

Transition – Establish a transition routine for students and equipment (e.g. expectations for what to do at the end of a game and how equipment is collected). This process was designed to limit time spent on management between activities.

Outcome measures

To obtain a measure of teaching quality, teaching practice was observed for two lessons prior to randomization (baseline) and again for two lessons at the end of the intervention period (follow-up - weeks 6 and 7) using the Quality Teaching Lesson Observation Scales (NSWDET, 2006). These scales assess teaching behavior in three research based constructs of teaching referred to as dimensions (Table 3). The dimensions assess teaching behavior relating to: i) intellectual quality (Newmann, 1991; Newmann et al., 1996); ii) quality learning environment (Marks et al., 1996); and iii) significance of learning (Ryan and Deci, 2000). Each dimension is made up of six elements assessing the overall dimension, with each element assessed using a rating scale from one to five based on a descriptive statement for each scale value (Figure 1). The sum of the elements within each dimension provided a variable for analysis (dimension range 6 – 30).

(Table 1 roughly here please)

(Figure 1 roughly here please)

The Quality Teaching Lesson Observation Scales were chosen as they are currently used as a classroom observation instrument in the school region involved in the study (NSW). The characteristics of this assessment instrument that enable an overall perspective of teaching quality include: i) a focus on the behavior of both the teacher and the learner (Rink, 2013); ii) coding measures that focus on pedagogy, the student, and content (Ward, 2013); and iii) an overall generic focus rather than a set of subject specific teaching behaviors (e.g. provision of active learning time or physical activity behavior) (Dyson, 2014).

With regard to lesson observations, assessors were blinded to treatment conditions at follow-up assessments with the exception of the first author (AM), who performed the intervention fidelity assessment during observations. Two research staff observed and coded all of the assessment lessons. Assessor training included rating of teacher performance using video previously rated by a panel of experts (>95% agreement rate required). Each assessor coded the lesson separately, with a single code determined for each element. If assessors did not agree on the coding of an element, the code was negotiated to agreement, or the lower of the two codes was used if agreement could not be sought. Inter-rater reliability of the individual scores of the assessors was high (ICC = 0.90, 95% CI 0.86, 0.92).

Instruction classification and intervention fidelity

Inadequate description of intervention procedures (van Sluijs et al., 2008) and intervention fidelity (Harvey and Jarrett, 2013) have been identified as issues in quality reporting of intervention effects. Evaluation of the method of instruction utilized (game-based or skill-based) was performed during the lesson observations (described above) using lesson observation scales (Turner and Martinek, 1992). Each lesson was judged against three skill-based statements and four game-based statements to obtain the percentage of agreement for each of these sets of statements (e.g. lesson agreement with one of four game based statements and two of three skill statements = 25% game agreement and 66% skills agreement, indicating a greater skills based lesson focus). These agreement values were used to indicate: i) if the method of instruction undertaken at each time period was in line with a skill based or game-centered approach, and ii) if the fidelity of the instruction undertaken by the intervention group teachers was in line with the true nature of the intervention.

Analysis

Statistical analyses were completed using IBM SPSS Statistics for Windows, Version 21.0 (2012 SPSS Inc., IBM Company Armonk, NY) and alpha levels were set at $p < 0.05$. All variables were checked for normality and satisfied the criteria. Independent samples t-tests were used to compare differences between intervention and control

groups at baseline. Linear mixed models were fitted to compare intervention and control groups for continuous variables. The fixed effects in the model were group (intervention and control), time (baseline and follow-up), group/time interaction and a repetition variable to determine if there was a difference in the lesson delivery between first and second trials during a time point. Differences of means and 95% confidence intervals (CIs) were determined using the linear mixed models. Analyses included all randomized participants. Cohen (1988)'s *d* was used to determine effect sizes (Post-test difference between intervention and control scores / Pooled pre-test standard deviation of intervention and control group scores).

Results

Seven out of ten invited schools consented to participation. Stratification clustered two schools in the low, two schools in the medium, and three schools into the high socio-economic strata, with four schools randomized into the intervention and three schools into the control group. Teaching experience was wide ranging among the participating teachers (Range: 3 – 24 years; Mean: 10.7 ± 7.2 years). There were two male and five female teachers, none of whom had completed any specific professional learning related to PE throughout their teaching careers, with all completing no more than two PE-based subjects at undergraduate training level. A male teacher was randomized to each condition, and there was no significant difference in teaching experience between

control and intervention teachers (Table 4).

(Table 4 roughly here please)

Instruction classification and intervention fidelity

Baseline coding of lesson observation scales displayed similar code agreement among intervention and control groups (Control: 13% game / 83% skills; Intervention: 13% game / 63% skill), indicating that the observed lessons were predominantly skills based. At follow-up, control group instruction remained in preference of a skills approach (21% game / 72% skills), whereas the intervention group had shifted to greater agreement with game-centered instruction (75% game / 0% skills), in line with the intention of the intervention.

Teaching quality

At baseline, the quality of teaching between control and intervention groups did not differ significantly across any of the dimensions of the Quality Teaching Lesson Observation Scales (NSWDET, 2006). Significant beneficial treatment effects were found from baseline to follow-up for total Quality Teaching (7 weeks: MD=15.3, 95% CI: 7.93 – 22.74, $p<0.001$, d=1.7), with the dimensions of Intellectual Quality (7 weeks: MD=6.5, 95% CI: 4.00 – 9.08, $p<0.001$, d=1.8), Quality Learning Environment (7 weeks: MD=4.5, 95% CI: 1.72 – 7.28, $p<0.001$, d=1.7) and Significance (7 weeks:

MD=4.3, 95% CI: 1.33 – 7.25, p=0.004, d=1.6) all displaying significant group-by-time interaction for the intervention group (Table 5).

(Table 5 roughly here please)

Discussion

The aim of this study was to evaluate the efficacy of a CPD intervention in producing changes in the PE teaching practice and teaching quality of generalist primary school teachers when the CPD addressed the use of a GCA. The intervention involved a CPD program delivered using an information session and in-class mentoring whilst utilizing an instructional framework to assist in the learning about and delivery of game-centered curriculum. The PLUNGE intervention resulted in the teachers demonstrating they could deliver game-based lessons, and produced a significant beneficial treatment effect on the quality of PE lessons measured using the Quality Teaching Lesson Observation Scales (NSWDET, 2006).

These findings demonstrate that well designed CPD can achieve changes in teaching practice. Importantly, the teaching practice demonstrated after the CPD intervention promoted a broad range of student outcomes through the complexity of GCA learning experiences, and teaching practice was significantly higher in quality. Ultimately, achievement of student outcomes is the desired aim, and lasting changes in teaching behavior are said to be preceded by evidence of student change (Guskey, 2002;

Klingner, 2004). Students exposed to the teaching delivered during the PLUNGE CPD demonstrated significant improvements in game play outcomes (Miller et al., 2016) whilst simultaneously improving in-class PA and FMS (Miller et al., 2016; Miller et al., 2015). Whilst it is not possible to demonstrate that the change in teaching quality mediated the changes in student outcomes, the evidence demonstrates that teachers in the intervention group presented higher quality teaching, and students in that group experienced significantly better outcomes.

The PLUNGE intervention (Miller et al., 2016; Miller et al., 2015) displayed equivalent effects on student outcomes as interventions focused solely on PA related teaching behaviors (McKenzie et al., 1998; Sallis et al., 1997; McKenzie et al., 2004; van Beurden et al., 2003). As such, this study forms a rationale for CPD that is focused on an understanding of the complexity of teaching that promotes high quality pedagogy, rather than a focus on teaching for a narrow range of outcomes. This CPD requires a focus on the teacher and the learner (Rink, 2013), promotes learning surrounding pedagogy, the student, and content (Ward, 2013), and can embrace multiple outcomes simultaneously (curricular and health promotion). To contribute to the discussion of improved teaching quality and CPD to support this within PE, the PLUNGE intervention is discussed below in relation to research in these fields.

Quality teaching

Researched constructs of teaching quality were operationalized within the planning and delivery of the PLUNGE CPD intervention. The goal was to improve overall quality rather than attempting to obtain higher levels for each element in the Quality Teaching Lesson Observation Scales (NSWDET, 2006). As elements often interact, not all elements can be improved/maximized simultaneously within an intervention/lesson (e.g. "student direction" is lacking in our intervention, but the increase in on-task time enabling greater opportunity for students to develop/display "deep understanding" was considered more important to the outcomes of this intervention). The research underpinning each dimension of Quality Teaching Lesson Observation Scales (NSWDET, 2006) is outlined below (related element in brackets). Intervention components that contributed to higher coding levels are described below for each dimension. Only the elements considered most relevant to producing the measured effects are discussed:

Intellectual quality

Instruction considered higher in intellectual quality (Newmann, 1991; Newmann et al., 1996) is associated with higher student achievement (Avery, 1999; Lee et al., 1997). Instruction that focuses on key concepts (deep knowledge), requires students to manipulate and synthesize information (higher-order thinking), addresses the social

construction of knowledge from multiple perspectives (problematic knowledge), and requires students to display deep understanding through substantive responses (substantive communication) is considered to be high in intellectual quality (Newmann, 1991; Newmann et al., 1996).

In an effort to enhance intellectual quality within the PLUNGE intervention, deep knowledge was promoted through a curriculum designed to present continuous focus on the key physical (throw, catch and kick) and tactical (decision making and support play) skill outcomes. An increase in complexity within lessons, and across the intervention period was also in line with planning recommendations for non-linear pedagogy (Tan et al., 2011). Higher-order thinking was promoted through game-centered activities that presented students with challenges requiring them to combine physical and tactical skills in order to respond to the individual, environmental, and task constraints placed upon them (Chow et al., 2007). These activities required students to synthesize and manipulate information to solve problems.

Problematic knowledge was promoted through exploration of how a quality game/activity is defined in the pre-intervention workshop, with the intent of having students recognize that concepts of winning, performance, participation, fairness and enjoyment in PE are socially constructed, and that they as a group can construct their own version of quality in their PE program (with a focus on a class friendly version). Additionally, exploration of multiple ways of achieving a performance outcome

(physical or game skill) via use of questioning and feedback during the "stop – learn" segment of the delivery routine were included to present knowledge as problematic.

Substantive communication was promoted through questioning surrounding concepts and student understanding during the "stop – learn" segment of the instructional framework. The combination of substantive communication with the elements of intellectual quality previously described produced the significant improvement observed within the intellectual quality dimension of Quality Teaching Lesson Observation Scales (NSWDET, 2006).

Quality learning environment

Creating a high quality learning environment in which students feel socially supported is important in engaging students (Marks et al., 1996). According to Newmann (1992), engaged students make a "psychological investment in learning. They try hard to learn what school offers." (pp. 2–3). Providing students with visible pedagogy with clear criteria of what constitutes quality (explicit quality criteria) (Bernstein, 1997), building social support (social support) (Marks et al., 1996), challenging students at their own level (high expectations) (Brophy, 1998; Good and Brophy, 2003), and giving students some control over their learning (student direction) (Beane, 1993; Bernstein, 1990) are all recommended in the creation of a high quality learning environment.

In an effort to enhance the quality of the learning environment within the PLUNGE intervention, explicit quality criteria were addressed via: i) the development and referencing back to the class version of a quality game/activity, and ii) during the "stop – learn" section of the delivery routine when teachers gave feedback referring to a quality performance by a team or individuals in regard to physical, game or socio-cultural aspects of involvement in the activity.

Social support was promoted through: i) the construction of the class definition of quality games/activities; ii) the referencing back to this definition during activities to focus on process outcomes (Ames, 1992; Meece, 1991); iii) the inclusion of socio-cultural skills in the "evaluate" and "stop – learn" delivery routine (e.g. the teacher stopping and highlighting a student encouraging the team-mate who had made a mistake in the activity as a positive behavior); and iv) promoting positive peer recognition of effort, particularly in situations involving failure (Clifford et al., 1988).

High expectations were promoted through curriculum that utilizes a perception/action coupling (Gibson, 1979) and a range of constraints (Chow et al., 2007) to offer challenge. Additionally, to provide diversity of challenge among varied abilities (Nicholls, 1989; Marshall and Weinstein, 1984), modification of constraints was undertaken via the "evaluate" and "stop – modify" sections of the instructional framework (e.g addition of rules to form more complex games, changing defense and

attack ratios to provide challenge, or limiting advanced players to helping team-mates score rather than scoring themselves).

Student direction was promoted through individual response to challenges within activities, and student involvement in decision making regarding the rules of activities if they were to be modified. Despite still being student-centered, this is considered a low level of student direction, and was accepted as a limitation of the intervention in favor of the teacher maintaining outcome based activity. Once patterns of instruction and behavioral expectations have been established, this is an element that could be incorporated to a greater extent, and has great potential to further improve the significant positive changes observed in the quality learning environment dimension (NSWDET, 2006).

Significance

If knowledge is seen as relevant to the personal experience of a student, they are more likely to display more positive self-determined motivation towards the learning activities (Ryan and Deci, 2000). Within the learning process, connecting new knowledge to what is already known (background knowledge) (Bruner, 1977; Ashman and Conway, 1997), promoting democratic classrooms which are inclusive and respectful of difference (inclusivity), and using stories to bring content to life (narrative) (Egan, 1989) are recommended in making learning more significant for students.

In an effort to enhance significance within the PLUNGE intervention, background knowledge was promoted via the inclusion of the "learn – connect" section of the instructional framework. This was included to provide links between the lesson outcomes and exposure students may have had (not all students watch/experience sports competitions) to high level sporting competition (live or on television). Inclusivity was promoted through: i) the construction of the class definition of quality games/activities, ii) referencing back to this definition during activities within the "stop – learn" section of the instructional framework, and iii) modification of activities in the "stop – modify" section of the delivery routine to reduce over-competitive behaviors and promote an environment that valued participation by all students. Finally, narrative was promoted through: i) recounting game occurrences, or any personal experiences the teacher may have within the "stop – learn" section of the instructional framework, and ii) connection to external images (competitive sports) within the "stop – connect" section of the instructional framework.

Whilst incorporating knowledge of non-dominant groups (cultural knowledge) (Delpit, 1995), and connecting content to contexts outside of school (connectedness) (Newmann, 1993) are recommended in the creation of greater significance for students, these constructs were not specifically operationalized within the PLUNGE intervention planning and delivery. It was accepted that teachers would be respectful of the cultural differences within their class groups (cultural knowledge), and that students may be

inclined to participate in lunch-time and after-school activity though a better understanding of complex activities undertaken in a supportive environment (connectedness). However, these constructs may be incorporated to a greater extent once teachers develop greater understanding and autonomy in use of a GCA, and have great potential to further improve the significant positive changes observed in the significance dimension (NSWDET, 2006).

Professional development

The CPD methods utilized in the PLUNGE intervention (information session and mentoring) were not novel, but the focus on improving teaching quality through the use of curriculum, content and pedagogical knowledge, and the use of an instructional framework to scaffold this process were novel aspects not yet undertaken in quantitative research in primary PE.

In line with recommendations for effective CPD, the PLUNGE intervention: i) involved teachers as both learners and teachers (Darling-Hammond and McLaughlin, 1995) through the information session and mentoring process within their own PE lessons; ii) was needs-supportive (Aelterman et al., 2013) by assisting teachers at an individual level when implementing curriculum; iii) took place within the school day (Garet et al., 2001) during teachers' regular timetabled PE; iv) was collaborative with experts in the field (Armour and Yelling, 2007) through the utilization of the research

team during the information session and mentoring; and v) was integrated into practice (Garet et al., 2001; Armour and Yelling, 2007) during the teachers' regular PE lessons.

As these principles are more about the mechanics of the CPD process, the complexity of the process is better addressed from the perspective presented by Armour et al. (2015). The four recommendations presented by Armour et al for consideration within CPD are addressed below in relation to the CPD process undertaken within this investigation:

CPD should recognize the dazzling complexity of the learning process

The curriculum delivered by the teachers was designed to present multiple outcomes simultaneously (physical skills, game skills, socio-cultural skills and in-class PA), rather than highlighting one area of focus (e.g. motor skill development or PA outcomes), and was underpinned by researched principles of teaching quality. To assist teachers in the complexity of addressing multiple outcomes within their lessons the CPD program included delivery and development of content and pedagogical knowledge through the information session and in-class mentoring.

The purpose of the in-class mentoring was to contextualize the theoretical content presented to teachers in a situated learning environment (Lave and Wenger, 1991). To assist with an understanding of the complexity of using a game-centered curriculum, and development of multiple outcomes simultaneously, in-class mentoring

was scaffolded using an instructional framework. The framework enabled the scaffolding of large amounts of theoretical knowledge into an accessible format for the teachers involved.

Whilst the structure of the instructional framework appears prescriptive for the delivery of the game-based curriculum, the nature of the framework actually provided a platform for exploration of new knowledge as it asked teachers to evaluate activities with multiple teaching outcomes in mind. As each class responded differently to the activities due to the constraints present within the class (e.g. social environment, mix of skill levels, physical development of students), this process enabled the complex nature of a PE class to be viewed by the intervention teachers, rather than a singular focus towards skill improvement being valued within PE classes, which was demonstrated by the pre-intervention lesson instructional classification.

CPD should understand context and contemporary challenges

Mentoring of teachers after the information session was designed to contextualize the content and create a situated learning environment (Lave and Wenger, 1991). The individual context of each class could be addressed within delivery of the curriculum through this process.

With regard to addressing contemporary challenges, the promotion of school PE as a vehicle for PA promotion (Cox et al., 2010; Pate et al., 2006; Timperio et al., 2004;

van Sluijs et al., 2007) puts pressure on teachers not confident teaching PE (Morgan and Hansen, 2008) to produce active lessons that still fulfill curriculum outcomes. This study and the CPD process addressed this issue, enabling teachers to undertake game-based lessons with high PA levels, whilst simultaneously working towards motor skill and game-play outcomes (Miller et al., 2015; Miller et al., 2016). These effects on PA levels and development of FMS were equivalent to those produced by previous interventions (McKenzie et al., 1998; Sallis et al., 1997; McKenzie et al., 2004; van Beurden et al., 2003), whilst still addressing socio-cultural and game based outcomes within the expected curriculum (Board of Studies New South Wales, 2007).

CPD should search to bridge research/theory – practice in innovative ways

The curriculum delivered by teachers during the PLUNGE intervention was based on the principles of non-linear pedagogy (Chow et al., 2007) in which learning was based in the learners' interaction with the individual, environmental, and task constraints placed upon them (Chow et al., 2007). Delivery required engagement of teachers with pedagogy, their students, and content - an important trio in addressing teacher effectiveness (Ward, 2013). This process was grounded through the research surrounding teaching quality, which was operationalized within intervention planning and delivery.

This research grounding was presented to teachers during the information session component of the CPD, and applied within the class environment with the research team member during the in-class mentoring. The innovative practice within this intervention was the use of the instructional framework to scaffold the connection of the underpinning research within the in-class mentoring, and is considered a strength of the design of this investigation. Whilst this process aided in the translation of research into the intervention delivery, and aided in producing changes in teacher practice that in turn had a positive effect on multiple student outcomes (Miller et al., 2015; Miller et al., 2016), it is accepted that this process does not fully elucidate to the teacher the complete suite of research that underpins the intervention. It is suggested that this strategy form an initial progression within a longer CPD process that further connects this research to teaching and learning outcomes.

CPD should focus on career-long growth of PE teachers

The PLUNGE CPD intervention saw the teachers involved producing games-based lessons focused on the development of multiple student outcomes simultaneously. The teaching practice of the intervention teachers was of significantly greater quality than their pre-intervention lessons, and their learning process was situated within their own teaching practice with their students. Just as the inclusion of explicit quality criteria (Bernstein, 1997) helped the students to identify what a quality performance was within

activities, the intervention teachers now have a working model of what a higher quality PE class looks like, and are aware of the outcomes that can be achieved through teaching in this way. It is accepted, however, that this intervention was not focused on the career-long development of these teachers within the PE domain, but was a very intensive starting point that could be developed upon through future research and/or CPD activities.

Strengths and limitations

The PLUNGE intervention represents a novel method of exposing teachers to CPD for the development of both teaching quality and student outcomes, and forms important evidence linking CPD to changes in teaching behavior. The strengths of this study are: i) evaluation of the intervention was performed via a cluster randomized controlled trial, ii) current best practice principles were applied to the CPD intervention, and iii) pedagogical and content knowledge were operationalized within the intervention through the use of an instructional framework.

Despite the novelty of this study, there are some limitations that should be noted. First, this was an efficacy trial to test the effectiveness of this particular intervention against usual practice, and not a theory of change (Weiss, 1995) study, and as such, we cannot determine the components of the intervention that may have brought about change. Future investigations using multiple study arms (different CPD methods

utilizing the same curriculum) are suggested to explore the efficacy of different models of CPD. Second, the intervention period was relatively short and the sample size relatively small compared to previous interventions of this nature. Third, there was no longer term follow-up of teaching behavior, so the possible effects on longer term and sustained high quality teaching practice is unknown. Fourth, the sample of teachers involved in this investigation accepted an invitation to participate, and as such the CPD occurred in a context of collaborative endeavor (Kennedy, 2005). Thus, generalization of results across the broader primary teaching community is ill advised. Finally, a quantitative process evaluation was not undertaken. Interview data was obtained regarding teacher interaction with the professional learning program and views on the feasibility of the CPD approach, but it is beyond the scope of this manuscript to provide analysis of these data.

Conclusion

Ward (2013: 437) states that "you get what you teach", highlighting that quality matters in learning and that two groups of students can obtain the same measured outcomes, but what they learn about those outcomes can be very different. In this study, CPD involving an information session and mentoring, and a focus on the development of the quality of teaching using a game-centered pedagogical approach demonstrated effectiveness in improving the quality of PE teaching among generalist primary school

teachers. The PLUNGE intervention enabled teachers to deliver game-centered lessons and had a positive effect on the intellectual quality of lessons, the quality of the learning environment, and the significance of the learning experience. Importantly, as student outcomes are the ultimate aim, students undertaking the intervention significantly improved motor and game play skills whilst performing greater levels of in-class physical activity compared to those in a control group (Miller et al., 2015; Miller et al., 2016). It is suggested that the longer term sustainability of the positive efficacy observed should be tested with future investigations of a larger scale for longer periods in which the CPD intervention undertaken here forms the first phase in a longer process of development designed at producing longer-term change in the PE teaching practice of primary school teachers.

1.1 Deep knowledge

Description

Knowledge is deep when it concerns the central ideas or concepts of a topic, subject or KLA and when the knowledge is judged to be crucial to the topic, subject or KLA. Deep knowledge is evident when either the teacher or the students provide information, reasoning or arguments that address the centrality or complexity of a key concept or idea, or when relatively complex relations are established to other central concepts.

Knowledge is shallow or superficial when it does not concern significant concepts or key ideas of a topic, subject or KLA, or when concepts or ideas are fragmented and disconnected from a central focus. Knowledge is also shallow when important ideas are treated superficially by the teacher or students, or when there is no clear focus on an important idea or concept. This superficiality can arise from trying to cover large quantities of fragmented information that results in the content covered remaining unconnected to central ideas or concepts.

Notes

1. The essential difference between deep knowledge and deep understanding is that deep knowledge is about how **content** is presented in a lesson, while deep understanding is about the **learning** students demonstrate. It is possible for deep knowledge to be presented (by the teacher, students or guest speakers), but for students to demonstrate only superficial understanding, or vice versa.
2. In curriculum debates, a strong distinction is often made between **depth** and **breadth** of knowledge, which at times pits one against the other. It is important to recognise that substantial syllabus content coverage (some breadth) is necessary in order to achieve depth of knowledge. Consequently, depth cannot be achieved simply by focusing on "less" content.
3. The main issue related to deep knowledge is one of **quality**. Deep knowledge requires relevant syllabus content to be organised and taught in such a way that a small number of ideas or concepts are clearly established as the focus of the lesson. Depth is present if the content of a lesson is structured such that the central focus brings coherence and purpose to the lesson.

Coding scale

To what extent is the knowledge being addressed focused on a small number of key concepts and the relationships between and among concepts?

Deep knowledge

① Almost all of the content knowledge of the lesson is shallow because it does not deal with significant concepts or ideas.

② Some key concepts and ideas are mentioned or covered by the teacher or students, but only at a superficial level.

③ Knowledge is treated unevenly during instruction. A significant idea may be addressed as part of the lesson, but in general the focus on key concepts and ideas is not sustained throughout the lesson.

④ Most of the content knowledge of the lesson is deep. Sustained focus on central concepts or ideas is occasionally interrupted by superficial or unrelated ideas or concepts.

⑤ Knowledge is deep because focus is sustained on key ideas or concepts throughout the lesson.

Suggestions

- Identify and review students' prior knowledge as a starting place for addressing deep knowledge.
- Identify significant concepts in syllabuses by reviewing objectives, outcomes, content (e.g. *learn about* and *learn to* statements) and stage statements. Reflect on how the syllabus content can explicitly illustrate the concepts.
- Identify the key concepts and relationships to be addressed by asking the questions: *What do I want the students to learn*? and *Why does that learning matter*?
- Check that you have identified the key concept or relationship by asking the question: *How well does the concept or relationship draw the content together*?
- Map outcomes and content during unit planning so that each lesson focuses on illustrating significant concepts while addressing manageable amounts of content.
- Connect key concepts being addressed from lesson to lesson.
- Use learning tools in both planning and teaching to connect, identify and clarify knowledge, e.g. concept maps which explain relationships within a complex issue or topic.
- Select specialised resources carefully to build deep knowledge. These could include field experts, the local community and services, the Internet, multimedia and out-of-school visits.
- Provide unit or module overviews for students so that they can see how the concepts fit into the overall picture.

Figure 1. Quality Teaching Lesson Observation Scales - element coding example

Table 1. *PLUNGE intervention components (Australia from September to December 2013)*

Information session content	In-class mentoring content

Instructional (in-class theory)
- Connection of a Game Centered Approach to the existing NSW Personal Development Health and Physical Education syllabus (Board of Studies New South Wales, 2007)
- Active Learning Time (ALT)
- Use of instruction routine with developed curriculum
- Development of motor skills, cognition of game play and socio-cultural (team-work, co-operation, etc..) outcomes within game play
- The use of questioning to assist student cognition
- The use of feedback to assist student cognition/understanding of quality performance
- Identification and use of Teachable Moments in PE classes
- Development of a learning environment to foster mastery motivation
Theoretical:
- Physical activity research findings
- Theoretical grounding: achievement goal theory (Nicholls, 1989)
- Game Centered Approach research overview
- Game Centered Approach comparison to a direct instruction methodology
- Mastery motivation within PE classes:
  - Diversity of challenge (Nicholls, 1989; Marshall and Weinstein, 1984)
  - Individual development of process related aspects of learning tasks (Ames, 1992; Meece, 1991)
  - Coordination of curriculum and instructional motivational goals (Marshall, 1988; Ames, 1992)
  - Individual development of process related aspects of learning tasks (Ames, 1992; Meece, 1991)
  - Coordination of curriculum and instructional motivational goals (Marshall, 1988; Ames, 1992)
	Structural:
	- Establishing expectations
	- Efficient game setup and instruction
	- Classroom management during stoppages
	Promotion of learning:
	- Developing effective game environments
	- Game appreciation
	- Use of questioning to identify learning focus (motor skill, game cognition or socio-cultural)
	- Use of feedback for recognition of quality performance within activities
	- Promoting cognition
	- Throw, catch and kick skills
	- Establish equity based constraints
	- Recognizing teachable moments
	Class environment:
	- Negotiation with students regarding acceptable behaviors during group activities
	- Negotiation with students regarding the definition of quality behavior during group activities
	- Positive support of classmates
	- Contribution by all
	- Fun and fair games
	- Diminishing over-competitive behavior/reaction
	Motivational:
	- Promote personal improvement of process outcomes within activities (Meece, 1991; Ames, 1992)
	- Promotion of class focus of the game process, not the result (Meece, 1991; Ames, 1992)
	- Promote personal improvement of process outcomes within activities (Meece, 1991; Ames, 1992)
	- Promotion of class focus of the game process, not the result (Meece, 1991; Ames, 1992)
	- Help students establish a class version of a quality game performance (Nolen and Haladyna, 1990)
	- Promote positive peer recognition of effort, particularly in situations involving failure (Clifford et al., 1988)
	- Provide private recognition of effort and improvement (Garner, 1990)

Table 2. *PLUNGE curriculum overview (Australia from September to December 2013)*

Week	Curriculum
Pre-intervention session	Mentor and teacher facilitate a short (10-15 minute) session in which the class develops a class based version of what makes up a successful game/activity. This definition is then referred to as the definition of a quality activity throughout the intervention period. Aim: To move the class away from the typical version of success within activities (winning, scoring), to a more socially constructed version of quality activities, where success is defined as: i) students of all ability levels being involved in activities, ii) failure is recognized as necessary in the development of abilities, iii) personal improvement is a successful outcome regardless of the level of performance, and iv) the way we treat each other in a class is a greater measure of success than the score.
Week 1: Throw, catch, kick	Aim: Develop current throw, catch and kick skills and begin game appreciation process and development of constructive classroom environment Emphasis: Target games rather than invasion games to develop physical skills in a game like environment, without the pressure of invasion games Tactical complexity: Low (target games) Style of activities: Partner
Week 2: Moving targets	Aim: Develop current throw, catch and kick skills whilst tracking moving players (movement of ball to moving players / off ball support) Emphasis: Target games rather than invasion games to develop skills in a game like environment, without the pressure of invasion games Tactical complexity: Increases to target games with increasing amounts of interaction between players / no defense Style of activities: Partner and small group activities (groups of 3)
Week 3: Attacking a target	Aim: Use of propulsion skills to attack a target without the pressure of defenders attacking the ball Emphasis: Use of physical and game skills to out-do the defender of the target Tactical complexity: Increases to small group target games with defense of the target Style of activities: Small group activities (groups of 3 - 5)
Week 4: Finding space - 1	Aim: Develop the ability to support attacking play with off ball movement Emphasis: Movement into space to create options for the player who has the ball Tactical complexity: Increases to possession games where defenders are trying to obtain the ball, but the attack to defense ratio is high (3 attackers to 1 defender) Style of activities: Small group activities (groups of 3 - 6)
Week 5: Finding space - 2	Aim: Develop the ability to support attacking play with off ball movement Emphasis: Movement into space to create options for the player who has the ball Tactical complexity: Increases to possession games where attack to defense ratio is equal (3 attackers to 3 defenders) and modified invasion games (5 attackers to 2 defenders) Style of activities: Medium group activities (groups of 6 - 10)
Week 6: Attacking play (Throw and catch)	Aim: Develop the combination of on and off ball skills when creating attacking raids using throw and catch skills (invasion) Emphasis: Execution of throwing skills and recycling support Tactical complexity: Increases to modified invasion games where attack to defense ratio is equal (3 attackers to 3 defenders) Style of activities: Medium group activities (groups of 6 - 12)
Week 7: Attacking play (Kick)	Aim: Develop the combination of on and off ball skills when creating attacking raids using kicking skills Emphasis: Execution of kicking skills and recycling support Tactical complexity: Decreases to possession and modified invasion games with high attack/defense ratio (5 attackers to 2 defenders) *Note. Complexity decreases due to the emphasis on kick skills*. Style of activities: Medium group activities (groups of 6 - 12)

Table 3. *Quality Teaching Lesson Observation Scales - dimensions and elements*

Dimensions	**Intellectual quality**	**Quality learning environment**	**Significance**
	Deep knowledge	Explicit quality criteria	Background knowledge
	Deep understanding	Engagement	Cultural knowledge
Elements	Problematic knowledge	High expectations	Knowledge integration
	Higher-order thinking	Social support	Inclusivity
	Metalanguage	Students' self-regulation	Connectedness
	Substantive communication	Student direction	Narrative

Table 4. *PLUNGE Baseline characteristics of teachers randomized to the intervention and control groups (Australia from September to December 2013)*

Characteristics	Control (n = 3) (Obs[a] = 6)		PLUNGE intervention (n = 4) (Obs[a] = 8)		
	Mean	SD	Mean	SD	*P*
Teaching experience (years)	12.00	10.39	9.75	5.37	0.721
Quality Teaching					
Intellectual Quality[b]	14.67	0.58	14.38	1.55	0.773
Quality Learning Environment[b]	16.50	2.50	16.13	1.31	0.804
Significance[b]	10.83	1.26	11.63	0.85	0.362
Quality Teaching Total[c]	42.00	4.27	42.13	3.04	0.965

Notes.
[a] Obs = observations
[b] Values range 6 – 30.
[c] Values range 18 – 90.

Table 5. *PLUNGE Intervention effects (Australia from September to December 2013)*

Outcome	Treatment group		Adjusted mean difference between groups (95% CI)[b]	Group * Time	Effect size
	Mean change from baseline (95% CI)			P	(Cohen's d)
	Control (n = 3) (Obs[a] = 12)	PLUNGE intervention (n = 4) (Obs[a] = 16)			
Quality Teaching					
Intellectual Quality	-0.17 (-1.77 – 2.11)	6.37 (4.70 – 8.05)	6.54 (4.00 – 9.08)	< 0.001*	1.77
Quality Learning Environment	0.00 (-1.19 – 1.19)	4.50 (3.47 – 5.53)	4.50 (1.72 – 7.28)	< 0.001*	1.65
Significance	-0.17 (-2.20 – 1.87)	4.12 (2.36 – 5.89)	4.29 (1.33 – 7.25)	0.004*	1.60
Quality Teaching Total	-0.33 (-4.38 – 3.72)	15.00 (11.49 – 18.51)	15.33 (7.93 – 22.74)	< 0.001*	1.72

Notes.
** Significance at p < 0.05.*
[a] Obs = observations
[b] *Between group difference of change score (intervention minus control).*

References

Aelterman N, Vansteenkiste M, Van Keer H, et al. (2013) Development and evaluation of a training on need-supportive teaching in physical education: Qualitative and quantitative findings. *Teaching and Teacher Education* 29: 64-75.

Ames C. (1992) Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology* 84: 261-271.

Amosa W, Ladwig JG, Griffiths T, et al. (2007) Equity effects of Quality Teaching: Closing the gap. *Australian Association for Research in Education conference.*

Armour K, Quennerstedt M, Chambers F, et al. (2015) What is 'effective' CPD for contemporary physical education teachers? A Deweyan framework. *Sport, Education and Society*: 1-13.

Armour K and Yelling M. (2007) Effective professional development for physical education teachers: The role of informal, collaborative learning. *Journal of Teaching in Physical Education* 26: 177-200.

Ashman A and Conway R. (1997) *An introduction to cognitive education: Theory and application,* London: Routledge.

Atencio M, Yi CJ, Clara TWK, et al. (2014) Using a complex and nonlinear pedagogical approach to design practical primary physical education lessons. *European Physical Education Review* 20: 244-263.

Australian Curriculum Assessment and Reporting Authority. (2015) The Australian Curriculum: Health and Physical Education, Version 8.1. Sydney.

Australian Primary Principals Association. (2014) Submission to Review of the Australian National Curriculum: Executive Summary. *Connected Leader*.

Avery PG. (1999) Authentic assessment and instruction. *Social Education* 63: 368-373.

Beane JA. (1993) *A middle school curriculum: From rhetoric to reality,* Columbus, OH: National Middle School Association.

Bernstein B. (1990) *The structuring of pedagogic discourse: Class, codes and control: Volume IV,* London: Routledge & Kegan Paul.

Bernstein B. (1997) Class and pedagogies: Visible and invisible. In: Halsey AH, Lauder H, Brown P, et al. (eds) *Education: Culture, economy and society.* Oxford: Oxford University Press, 59-79.

Biesta G. (2010) Five theses on complexity reduction and its politics. In: Osberg D and Biesta G (eds) *Complexity Theory and the Politics of Education.* Rotterdam: Sense Publishers, 5-14.

Board of Studies New South Wales. (2007) Personal Development, Health and Physical Education K-6: Syllabus. Sydney, Australia: Board of Studies NSW.

Brophy J. (1998) *Motivating students to learn,* Boston: McGraw-Hill.

Bruner J. (1977) *Processes of education,* Cambridge, Mass: Harvard University Press.

Bunker D and Thorpe R. (1982) A model for the teaching of games in secondary schools. *Bulletin of Physical Education* 18: 5-8.

Chow J, Davids K, Button C, et al. (2007) The role of Nonlinear pedagogy in physical education. *Review of Educational Research* 77: 251-278.

Chow JY and Atencio M. (2012) Complex and nonlinear pedagogy and the implications for physical education. *Sport, Education and Society*: 1-21.

Clifford MM, Kim A and McDonald BA. (1988) Responses to Failure as Influenced by Task Attribution, Outcome Attribution, and Failure Tolerance. *The Journal of Experimental Education* 57: 19-37.

Coulter M and Woods CB. (2012) Primary teachers' experience of a physical education professional development programme. *Irish Educational Studies* 31: 329-343.

Cox M, Schofield G and Kolt GS. (2010) Responsibility for children's physical activity: Parental, child, and teacher perspectives. *Journal of Science and Medicine in Sport* 13: 46-52.

Darling-Hammond L. (2000) Teacher Quality and Student Achievement. *2000* 8.

Darling-Hammond L and McLaughlin MW. (1995) Policies that support professional development in an era of reform. *Phi Delta Kappan* 76: 597.

Delpit L. (1995) *Other people's children: Cultural conflict in the classroom,* New York: The New Press.

den Duyn N. (1997) Game Sense - Developing Thinking Players Workbook. Canberra, ACT: Australian Sports Commission.

Dyson B. (2014) Quality Physical Education: A Commentary on Effective Physical Education Teaching. *Research Quarterly for Exercise & Sport* 85: 144-152.
Egan K. (1989) *Teaching as story telling,* Chicago: University of Chicago Press.
Fairclough SJ and Stratton G. (2006) Effects of a physical education intervention to improve student activity levels. *Physical Education & Sport Pedagogy* 11: 29-44.
Garet MS, Porter AC, Desimone L, et al. (2001) What Makes Professional Development Effective? Results From a National Sample of Teachers. *American Educational Research Journal* 38: 915-945.
Garner R. (1990) When children and adults do not use learning strategies: Toward a theory of settings. *Review of Educational Research* 60: 517.
Gibson JJ. (1979) *An ecological approach to visual perception,* Boston, MA: Houghton-Mifflin.
Good TL and Brophy JE. (2003) *Looking in classrooms,* Sydney: Pearson Education.
Gréhaigne J, Wallian N and Godbout P. (2005) Tactical-decision learning model and students' practices. *Physical Education & Sport Pedagogy* 10: 255-269.
Guskey TR. (2002) Professional Development and Teacher Change. *Teachers and Teaching* 8: 381-391.
Guskey TR and Yoon KS. (2009) What Works in Professional Development? *The Phi Delta Kappan* 90: 495-500.
Hallal PC, Andersen LB, Bull FC, et al. (2012) Global physical activity levels: surveillance progress, pitfalls, and prospects. *The Lancet* 380: 247-257.
Hardy L. (2010) NSW Schools Physical Activity and Nutrition Survey - Executive Summary. Sydney: The University of Sydney.
Harris J, Cale L and Musson H. (2010) The effects of a professional development programme on primary school teachers' perceptions of physical education. *Professional Development in Education* 37: 291-305.
Harvey S and Jarrett K. (2013) A review of the game-centred approaches to teaching and coaching literature since 2006. *Physical Education and Sport Pedagogy*: 1-23.
Hattie J. (2008) *Visible Learning : A Synthesis of Over 800 Meta-Analyses Relating to Achievement,* Hoboken: Taylor & Francis.
Hoban GF. (2002) *Teacher learning for educational change,* Buckingham: Open University Press.
Kennedy A. (2005) Models of Continuing Professional Development: a framework for analysis. *Journal of In-Service Education* 31: 235-250.
Kirk D and MacPhail A. (2002) Teaching games for understanding and situated learning: Rethinking the bunker-thorpe model. *Journal of Teaching in Physical Education* 21: 177-192.
Klingner JK. (2004) The science of professional development. *Journal of Learning Disabilities* 37: 248-255.
Lave J and Wenger E. (1991) *Situated learning: legitimate peripheral participation,* Cambridge: Cambridge University Press.
Lee VE, Smith J and Croninger R. (1997) How high school organization influences the equitable distribution of learning in mathematics and science. *Sociology of Education* 70: 128-150.
Lonsdale C, Rosenkranz RR, Peralta LR, et al. (2013) A systematic review and meta-analysis of interventions designed to increase moderate-to-vigorous physical activity in school physical education lessons. *Preventive Medicine* 56: 152-161.
Lubans DR, Morgan PJ, Cliff DP, et al. (2010) Fundamental movement skills in children and adolescents: review of associated health benefits. *Sports Med* 40: 1019 - 1035.
Marks HM, Doane KB and Secada WG. (1996) Support for student achievement. In: Newmann FM (ed) *Authentic achievement: Restructuring schools for intellectual quality.* San Francisco: Jossey-Bass, 209-227.
Marshall HH. (1988) In pursuit of learning-oriented classrooms. *Teaching and Teacher Education* 4: 85-98.
Marshall HH and Weinstein RS. (1984) Classroom Factors Affecting Students' Self-Evaluations: An Interactional Model. *Review of Educational Research* 54: 301-325.
McKenzie TL, Alcaraz JE, Sallis JF, et al. (1998) Effects of a physical education program on children's manipulative skills. *Journal of Teaching in Physical Education* 17: 327-341.
McKenzie TL and Lounsbery MAF. (2013) Physical Education Teacher Effectiveness in a Public Health Context. *Research Quarterly for Exercise & Sport* 84: 419-430.
McKenzie TL, Sallis JF, Prochaska JJ, et al. (2004) Evaluation of a two-year middle-school physical education intervention: M-SPAN. *Medicine and Science in Sports and Exercise* 36: 1382-1388.

Meece J. (1991) The classroom context and children's motivational goals. In: Maehr M and Pintrich P (eds) *Advances in achievement motivation research.* Greenwich, CT: JAI Press.
Memmert D and Harvey S. (2010) Identification of non-specific tactical tasks in invasion games. *Physical Education & Sport Pedagogy* 15: 287-305.
Miller A, Christensen EM, Eather N, et al. (2016) Can physical education and physical activity outcomes be developed simultaneously using a game-centered approach? *European Physical Education Review* 22: 113-133.
Miller A, Christensen EM, Eather N, et al. (2015) The PLUNGE randomized controlled trial: Evaluation of a games-based physical activity professional learning program in primary school physical education. *Preventive Medicine* 74: 1-8.
Moher D, Hopewell S, Schulz KF, et al. (2010) CONSORT 2010 explanation and elaboration: Updated guidelines for reporting parallel group randomised trials. *BMJ* 340.
Morgan P and Bourke S. (2008) Non-specialist teachers' confidence to teach PE: the nature and influence of personal school experiences in PE. *Physical Education and Sport Pedagogy* 13: 1-29.
Morgan P and Hansen V. (2007) Recommendations to Improve Primary School Physical Education: Classroom Teachers' Perspective. *Journal of Educational Research* 101: 99-111.
Morgan P and Hansen V. (2008) Classroom Teachers' Perceptions of the Impact of Barriers to Teaching Physical Education. *Research Quarterly for Exercise and Sport* 79: 506.
Newmann FM. (1991) Classroom thoughtfulness and students' higher order thinking: Common indicators and diverse social studies courses. *Theory and Research in Social Education* 19: 410-433.
Newmann FM. (1992) Student engagement and achievement in American secondary schools. New York: Teachers College Press.
Newmann FM. (1993) Beyond common sense in educational restructuring: The issue of content and linkage. *Educational Researcher* March 4-13.
Newmann FM, Marks HM and Gamoran A. (1996) Authentic pedagogy and student performance. *American Journal of Education* 104: 280-312.
Nicholls JG. (1989) *The competitive ethos and democratic education* Cambridge, MA: Harvard University Press.
Nolen SB and Haladyna TM. (1990) Personal and environmental influences on students' beliefs about effective study strategies. *Contemporary Educational Psychology* 15: 116-130.
NSW Department of Education and Training. (2006) *Quality teaching in NSW public schools - A classroom practice guide,* RYDE NSW: Department of Education and Training, Professional Support and Curriculum Directorate.
Pate RR, Davis MG, Robinson TN, et al. (2006) Promoting physical activity in children and youth a leadership role for schools: A scientific statement from the american heart association council on nutrition, physical activity, and metabolism (physical activity committee) in collaboration with the councils on cardiovascular disease in the young and cardiovascular nursing. *Circulation* 114: 1214-1224.
Petrie K. (2010) Creating confident, motivated teachers of physical education in primary schools. *European Physical Education Review* 16: 47-64.
Rhodes C and Beneicke S. (2003) Professional development support for poorly performing teachers: challenges and opportunities for school managers in addressing teacher learning needs. *Journal of In-Service Education* 29: 123-140.
Rink JE. (2013) Measuring Teacher Effectiveness in Physical Education. *Research Quarterly for Exercise and Sport* 84: 407-418.
Rockoff JE. (2004) The impact of individual teachers on student achievement: Evidence from panel data. *The American Economic Review* 94: 247-252.
Rowe K. (2003) The importance of teacher quality as a key determinant of students' experiences and outcomes of schooling. *ACER Research Conference.* Carlton Crest Hotel, Melbourne, 19-21 October.
Ryan RM and Deci EL. (2000) Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist* 55: 68-78.
Sallis JF, McKenzie TL, Alcaraz JE, et al. (1997) The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. Sports, Play and Active Recreation for Kids. *American Journal of Public Health* 87: 1328-1334.

Sinelnikov OA, Kim I, Ward P, et al. (2015) Changing beginning teachers' content knowledge and its effects on student learning. *Physical Education and Sport Pedagogy*: 1-16.
Sloan S. (2010) The continuing development of primary sector physical education: Working together to raise quality of provision. *European Physical Education Review* 16: 267-281.
Smith W. (2014) Fundamental movement skills and fundamental games skills are complementary pairs and should be taught in complementary ways at all stages of skill development. *Sport, Education and Society*: 1-12.
Stolz S and Pill S. (2014) Teaching games and sport for understanding: Exploring and reconsidering its relevance in physical education. *European Physical Education Review* 20: 36-71.
Tan CWK, Chow JY and Davids K. (2011) 'How does TGfU work?': examining the relationship between learning design in TGfU and a nonlinear pedagogy. *Physical Education and Sport Pedagogy* 17: 331-348.
Timperio A, Salmon J and Ball K. (2004) Evidence-based strategies to promote physical activity among children, adolescents and young adults: review and update. *Journal of Science and Medicine in Sport* 7: 20-29.
Turner A and Martinek TJ. (1992) A comparative analysis of two models for teaching games (Technique Approach and Game-Centered (Tactical Focus) Approach). *International Journal of Physical Education* 29: 15-31.
U. S. Department of Health and Human Services. (2012) Physical activity guidelines for Americans midcourse report: Strategies to increase physical activity among youth. Washington, DC.
van Beurden E, Barnett LM, Zask A, et al. (2003) Can we skill and activate children through primary school physical education lessons? "move it groove it"—a collaborative health promotion intervention. *Preventive Medicine* 36: 493-501.
van Sluijs EMF, McMinn AM and Griffin SJ. (2007) Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. *British Medical Journal* 335: 703.
van Sluijs EMF, McMinn AM and Griffin SJ. (2008) Effectiveness of interventions to promote physical activity in children and adolescents: systemic review of controlled trials. *British Journal of Sports Medicine* 42: 653-657.
Ward P. (2013) The Role of Content Knowledge in Conceptions of Teaching Effectiveness in Physical Education. *Research Quarterly for Exercise & Sport* 84: 431-440.
Weiss C. (1995) Nothing as Practical as Good Theory: Exploring Theory-Based Evaluation for Comprehensive Community Initiatives for Children and Families. In: Connell JI, Kubisch AC, Schorr L, et al. (eds) *New Approaches to Evaluating Community Initiatives: Concepts, Methods and Contexts.* New York: Aspen Institute, 65-92.